THE EXPLOSIVES ENGINEER

FORE-RUNNER OF PROGRESS IN
MINING-QUARRYING & CONSTRUCTION

SEPTEMBER-OCTOBER · 1959

VOLUME 37 · NUMBER 5

A thunderstorm three miles away

has been known to detonate a blast prematurely

For best protection against stray electric currents

You need not worry about stray electrical currents when you can hook-up and detonate with Primacord! It acts as the detonating agent throughout the entire column of explosives, or furnishes initiation to primers. This use of Primacord will result in safer, easier, quicker loading. Primacord also connects all holes, providing positive initiation, with results that you should find profitable.

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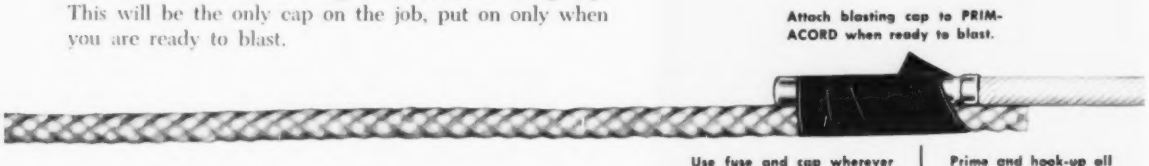

Use fuse and cap wherever stray currents are suspected.

Prime and hook-up all holes with PRIMACORD.

The trunk line illustrated is Lo-Temp® Primacord. For further information see your explosives supplier or write to

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THE EXPLOSIVES ENGINEER

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Forerunner of Progress in Mining, Quarrying, Construction

The Navajo Dam, while not a spectacular project when compared with some of the dams sponsored by the Bureau of Reclamation, does have a claim to fame. It is the second largest earth-fill dam undertaken by the Bureau. Its height will be 405 ft. and will have a crest length of 3,800 ft. The width at the base will be 2,600 ft. and 30 ft. at the crest. More than 26,300,000 cu. yd. of earth and rock will be required in building this structure.

Located in northwestern New Mexico, the Navajo Dam will serve as one of the principal storage units of the Colorado River Basin. A description of this project, written by Charles F. Thomas, starts on page 135.

° ° °

One phase of the Institute of Makers of Explosives' activities is its campaign warning children of the dangers of playing or tampering with blasting caps. Its most recent poster, "Keep Blasting Caps Locked Up," reproduced on page 145, is designed for company bulletin boards and other poster uses. Write to THE EXPLOSIVES ENGINEER, 613 Delaware Trust Building, Wilmington, Delaware, for a supply.

° ° °

Explosives once again prove their usefulness in helping to make a difficult job easier. The latest unusual application to be reported to us concerns the use of 60% Gelatin Extra to break up an underwater layer of limestone. William F. Hallstead tells how it was done in "Dynamite Speeds Dredging Project," starting on page 146.

EDITORIAL STAFF: JAMES J. O'NEILL, *Editor;* THOMAS E. MILLER, *Associate Editor;* GERTRUDE A. DONNELLY, *Associate Editor;* EDWARD L. GRANT, *Art Editor;* HOWARD B. DICKSON, *Production Manager;* A. J. ACKERMAN, *Advertising Manager;* MONTGOMERY R. BUDD, *Director.*

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Views and opinions expressed by the authors of articles in this publication are their own, and they do not necessarily represent those of the publisher.

An opportunity to observe Italian highway design and construction techniques was extended to Hercules representative Farrell Castellani when he was invited to join the American Bridge, Tunnel & Turnpike Association members on their tour of inspection of the Italian Autostrada del Sole.

Mr. Castellani's keen observations and his notes comparing various sections of the Autostrada with its American counterparts make his article, which starts on page 148, one of interest to all concerned with highway construction.

° ° °

It may seem a little premature to many of our readers to discuss the techniques of blasting ice floes; however, to be forewarned is to be prepared. So on page 154 in "Explosives Rescue A Town," Robert Dyment describes how Army Engineers used explosives to relieve a flooding condition which threatened Meadville, Pennsylvania.

° ° °

Erratum: It seems that no matter how carefully a magazine is edited, sooner or later an editor's nightmare on the use of the wrong terminology becomes a reality. Such an unfortunate error appeared in the title of the article in our July-August issue describing the operations of The Quartzite Stone Company, when we incorrectly used the designation "limestone" for "quartzite."

Obviously, the correct title of the article should have been "Quarrying A Hard Kansas Quartzite." We regret this slip in reportorial accuracy.

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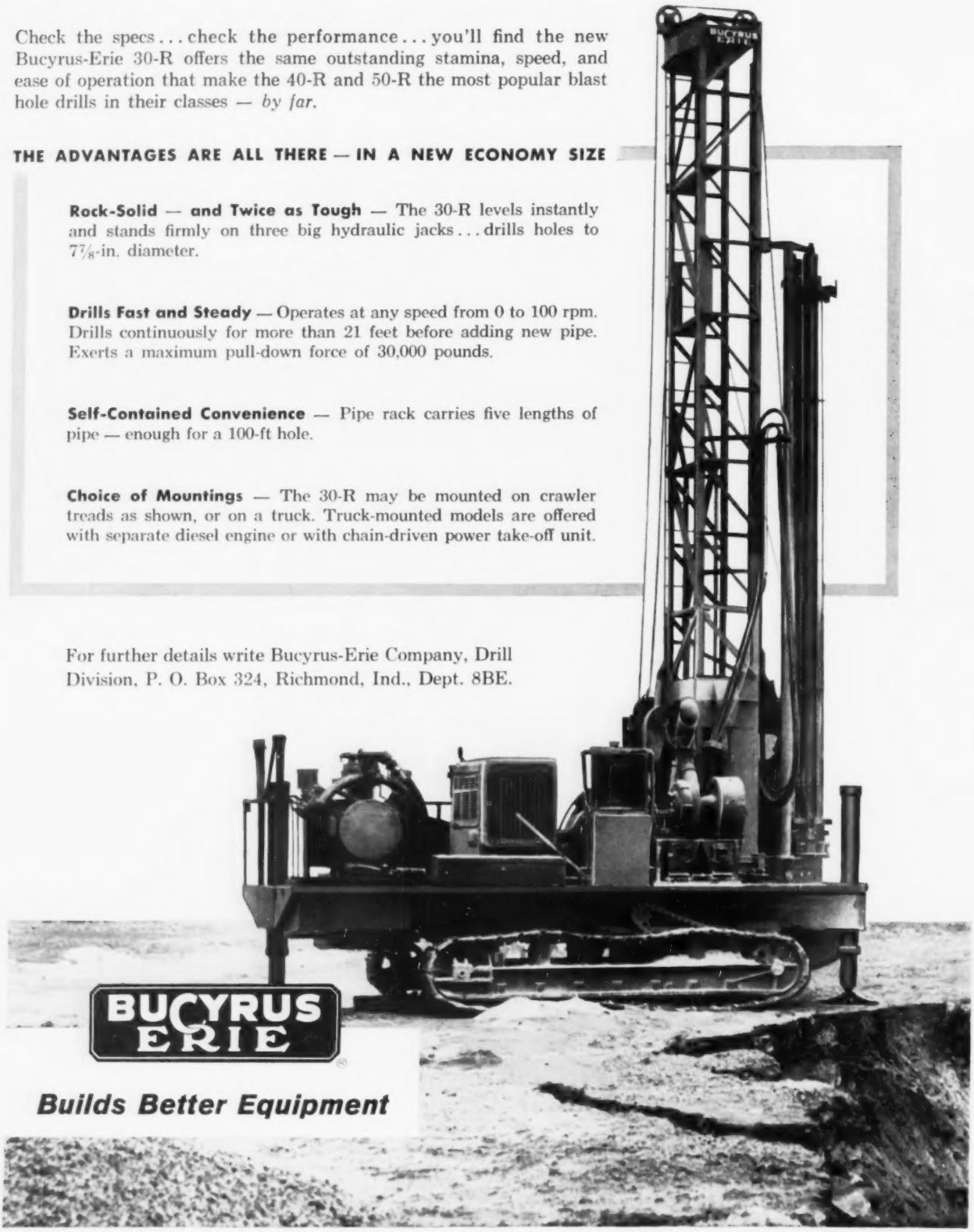

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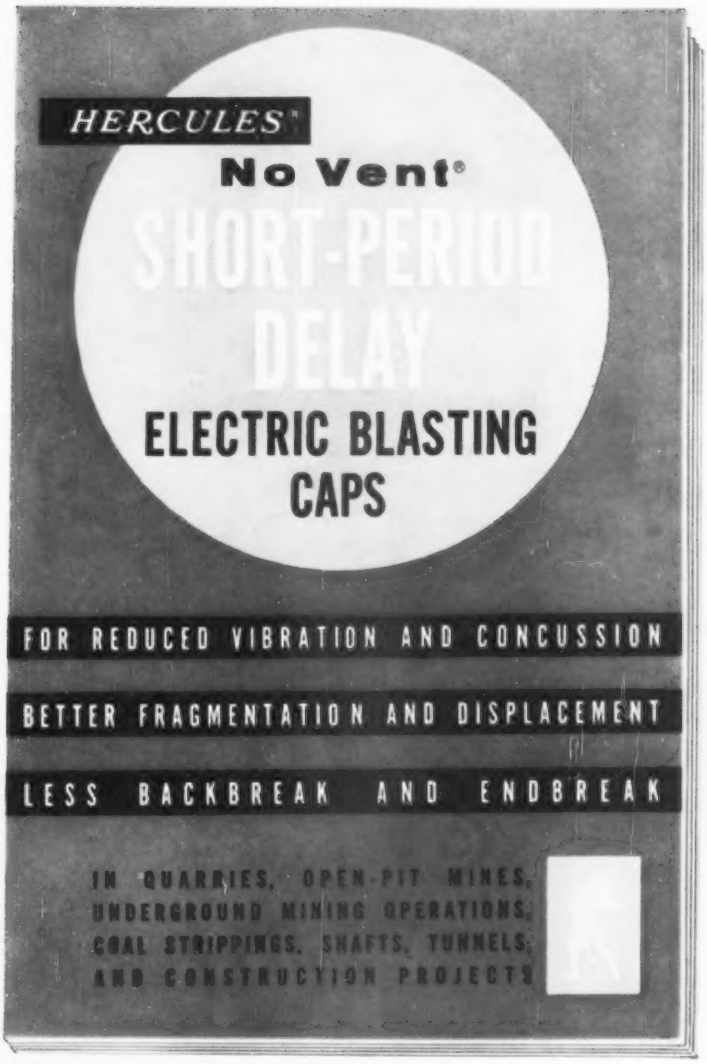
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LESS BACKBREAK AND ENDBREAK
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To help acquaint you with this extended series, Hercules has prepared a 20-page booklet describing the characteristics of the caps, indicated uses, and recommended procedures. If you don't already have a copy of this valuable guide, you'll want to ask your Hercules representative for one. At the same time, he'll be glad to tell you more about how Hercules Blasting Caps can best meet your specific requirements.

Explosives Department

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ROBERT PILLING BAYARD

Robert Pilling Bayard

EXECUTIVE VICE PRESIDENT
JOHNSON, DRAKE & PIPER, INC.

A Biography

On a wall in the reception room of the Foreign and Eastern Divisions' headquarters of Johnson, Drake & Piper, Inc., at 86 Trinity Place, New York City, is a large map of the world. Five of the six continents—Australia excepted—are studded with red pins showing the locations of construction projects performed by the company. The map shows a conspicuous cluster of pins in the Middle East, where "J.D.P." began its trend toward foreign construction jobs in remote corners of the earth that seem to bring problems unheard of on similar jobs inside the borders of continental United States.

The man who has borne the overall responsibility for these far-flung enterprises is Robert Pilling Bayard, executive vice president of the parent company, who is also president of the various wholly owned operating subsidiaries and a long-time employe of the company. A report on the Middle East contracts, which were undertaken during World War II for the United States Corps of Engineers, shows that the projects were located in eleven countries scattered over northern and central Africa, the eastern Mediterranean region, and the Arabian peninsula, an area almost as large as that of the United States. In this vast expanse, Bayard's men built a naval base on the Red Sea; eleven airports; an east-west line of emergency airport facilities, service camps, and fuel-storage facilities across the entire middle belt of Africa, running through Khartoum, the head of navigation on the Nile; fuel-storage facilities extending south into Mombasa, Nairobi, Kenya Colony; a general utility repair depot for the U.S. Signal Corps and a hospital and airport extension in Palestine.

In addition to these main features under this original Middle East contract, there were many other interesting and challenging undertakings of a more exploratory character in South Central and Southwest Africa, which were abandoned when Rommel was defeated in his efforts to conquer Cairo and take possession of the Middle East.

These tremendously widespread activities involved not only immense distances but many other problems that taxed the imagination and ingenuity of American engineers. In Egypt and the Sudan, and for some of the Saudi Arabian work, fuel and supplies had to be transported long distances across the desert from the seaports to the construction sites by camel caravans. Besides guarding against heat, precautions had to be taken against malaria, typhus, cholera, and venereal diseases so prevalent among the natives.

Planning this wide variety of construction jobs in these eleven countries required the procurement and importation of practically everything—from power shovels, tractors, and heavy diesel trucks down to the last cotter pin, as well as all necessary food and medical supplies and fuel and lube supplies, plus everything required for adequate housing. The challenging tasks of planning, directing, and executing these projects spread over this vast area fell to Bob Bayard and his capable staff.

Bayard's mother, Emma Louella Pilling Bayard, was of English ancestry. His father, Frederick Lewis Bayard, was a descendant of an old and prominent French Huguenot family that had emigrated to America. Colonel Samuel Bayard, who led the Bayards to the new world, married Peter Stuyvesant's sister. Stuyvesant, first governor of New Amsterdam, married Colonel Bayard's sister.

Born in St. Paul, Minnesota, Bob Bayard attended grade school and Mechanic Arts High School there and then the University of Minnesota. He played football four years in high school and four years at the university. At college, besides his football activities, he played some ice hockey and went out for track. He was a member of Phi Sigma Kappa. During summer vacations, in order to earn tuition money, he worked for the Great Northern and Northern Pacific Railroads on the survey parties engaged in extending their lines to the Pacific Coast. During the last three years at the university, he became chief of party with the Wisconsin Geological Survey, exploring for iron ore.

Armed with a degree in mining engineering, Bob signed up for a postgraduate course in engineering at the University of Wisconsin, but World War I intervened and he went to France with the Army Engineers. Demobolized in July of 1919, he took a job unloading sand at sixty-five cents an hour for a young construction company then known as Johnson and Drake.

Reflecting his years of experience in Asia, Europe, and Africa, Mr. Bayard speaks Spanish and French with fair fluency and Arabic and Italian well enough to get along.

He served as president of the New York State Highway Chapter of the Associated General Contractors and is currently vice president of the General Contractors of America in New York. He is president of the New York City Post of the Society of American Military Engineers; a member of the Moles, the New York State Labor Board, the University of Minnesota Alumni Association, and the "Paul Bunyan" Club (people who are interested in the University of Minnesota athletics). He plays golf at the Rockville Country Club at Rockville Centre, Long Island, and is a member of the New York Athletic Club. He still follows closely the fortunes of the Minnesota football team.

Robert Pilling Bayard married Bel Brandon in Pittsburgh in 1925. They have two daughters: Margaret Bel Bayard, married to Walter Mensching, an employe in the Foreign Service of Stanvac Oil Company; and Barbara Ann Bayard who is married to Kenneth Parsons, a construction engineer. After seven years in Indonesia and one year in the United States, the Menschings are now headed for Bombay, India, with their three small sons. Mr. and Mrs. Parsons and their son reside in Hartford, Connecticut. Mr. and Mrs. Bayard live at 28 Amherst Court, Rockville Centre, New York.

Editorial

Thunderstorm Detection

Experienced explosives users go to great lengths to guard against every conceivable hazard in the conduct of their blasting operations, expending sizable sums of money and time in this effort. One possible source of trouble, that of premature detonation from thunderstorms, is present often enough, and has caused enough unfortunate accidents, that mining, quarrying, and contracting operations should make sure they have protected themselves against it.

Blasters realize that operations should be suspended upon the approach of a thunderstorm, but the real need is to detect the approach of a dangerous storm far enough ahead to permit the suspension of operations *before* the danger has arrived.

Utility companies, for years, have used an ordinary AM (not FM) radio to warn themselves of the approach of a storm, particularly in the daytime, for the darkness accompanying the storm brings with it a great surge in the demand for light for which the generating station must be prepared. Blasting operations also can make use of the radio for thunderstorm detection.

The dial of the radio should be set to a frequency where no station is heard so that no broadcast program will hide the noise of static. The volume should be turned up to a point where the crackling of static discharges is readily heard. A radio so tuned in an office on the job, where someone is always present to check the sound and report an increase in static, can warn the blasting foreman to suspend blasting and remove men and equipment to a safe place.

An automobile radio with the volume turned up high at a point where explosives are being loaded, such as a construction project, quarry face, or a stripping pit, can serve the same purpose. The car radio can be particularly handy for remote blasting jobs, and more use should be made of this means of protection against premature detonation from thunderstorms, especially on close, sultry summer days, or when thunderheads on the horizon indicate an approaching storm. A radio in a mine, shaft, or tunnel may provide a valuable warning, especially if the antenna is outside.

At one time a storm detector was on the market, which would sound a horn as much as an hour in advance of the approach of a storm, but apparently this device is no longer available. The AM radio, however, seems to provide a readily available warning, and more operations should avail themselves of this comparatively simple expedient.

Caveat Emptor

Caveat emptor, let the buyer beware, is an old legal maxim, which warns the buyer to make sure he knows what he's buying since he has no recourse if the merchandise does not live up to his expectations. The manufacturer of blasting caps can put a different interpretation on this old legal saying. Far be it from us to imply that such is the explosives industry's merchandising policy. Rather, we mean that the industry must impress upon the buyers of caps that they should beware of the caps they buy, lest they fall into the hands of children.

On page 145 of this issue, the most recent copy of the users' poster prepared and distributed by the Institute of Makers of Explosives is reproduced. "Keep blasting caps locked up! so children can't find them and get hurt" warns the poster. "Keep track of every cap."

A message on the reverse side of the poster says, "While the protection of the children has always been our greatest concern, the clippings shown above disclose another side of this problem." The newspaper clippings referred to say, "Polk Boy Who Lost Eye in Blast Sues for $500,000," "West Newbury Boys Get $8,250 in Settled Suit," and "Suit Over Blasting Caps Injuries to Boys on Trial."

The Institute of Makers of Explosives wants to explore every possible avenue which promises a reduction in these distressing accidents to children. Without doubt, care in the handling of caps can help prevent these accidents, an end surely deserving of our best thought and foresight.

"Keep blasting caps locked up" is sound advice, to the point, and worthy of the profound attention of the explosives user.

The Institute has waged an unending campaign to warn children of this danger, and has had the cooperation of many agencies who work with the boys and girls. Even so, not every boy and girl is impressed with the warning, and some fail to realize these caps really are dangerous and should not be touched.

"Keep track of the caps" is a helpful procedure to keep them away from children. Keep them under lock and key, return them to locked magazines at the end of each day's work, make it difficult—if not impossible—for boys and girls to get at the caps. That way, we will save young eyes, limbs, and fingers, and we can be proud of our concern for the youngsters who show too much daring, too little caution.

Storing Water For Thirsty Days

The Navajo Dam, now being built in northwestern New Mexico, will add 1,712,000 acre-feet of water storage to the Bureau of Reclamation's Colorado River Project

CHARLES F. THOMAS°

NAVAJO DAM, now being constructed on the San Juan River in northwestern New Mexico under supervision of the United States Bureau of Reclamation, is not a spectacular project when compared to Hoover, Grand Coulee, or Glen Canyon Dams. It approaches top rank, however, in its class of earth-fill dams, being the second largest dam of this type undertaken by the Bureau of Reclamation. The project will serve as one of the principal storage units of the Colorado River Storage Project, and is planned to provide irrigation water for the 110,630-acre Navajo Project by impounding floodwaters of the San Juan River.

The influence of the early Spanish explorers is seen in the names of the rivers, canyons, mountain ranges, villages, and cities of the entire region.

°Box 978
Palmdale, California

PANORAMA: This panoramic view of the Navajo damsite shows the outlet tunnel, the spillway chute, and some of the service facilities needed to construct this vast project.

SPILLWAY AREA: Excavation in the spillway and stilling basin area progressed according to schedule. The auxiliary tunnel outlet portal is shown in the center of the photo.

Most retain their Spanish names euphoniously describing a natural condition or appearance, or a dedication to their patron saints.

Less than half a century after the discovery of America the Spaniards were exploring these regions. A century before the Pilgrim Fathers landed at Plymouth Rock, Spanish conquistadores had captured Mexico City and were reaching northward. Along the streams they were developing farms, establishing missions, and building villages and forts. The Indians possessing the lands through long centuries of habitation were massacred or forced into involuntary servitude. Alarcon had discovered the Colorado River and during the 1700's explorers were traveling farther into the canyons and mountains to the north and west. They sought gold or fabulous cities but always recognized the value of water flowing from the snow-capped mountain ranges.

In a state where Indian reservations constitute a sizable part of its area it is difficult to plan a project of this size without conflict with some Indian tribe or a political group over rights and privileges. The potential values of this damsite were recognized many years ago. In 1915 the lands surrounding it were withdrawn from public entry and reserved for water storage or power purposes if a dam were ever constructed.

The dam lies 15 miles south of the border of Colorado and New Mexico and 80 miles east of what is commonly referred to as Four Corners, that point common to the four states of Arizona, Colorado, Utah, and New Mexico. The project is bounded on the east by the Jicarilla-Apache Indian reservations. On the south and west, the barren desert and mesa lands of the Navajos fringe the area. To the north lies a portion of the Ute Indian reservation, with a majestic background of the San Juan mountain range rising to heights of nearly 14,000 ft. The dam is 39 miles due east of Farmington, a thriving boom city that grew up overnight from a struggling small desert farm community, when uranium, oil, and gas were found in the surrounding regions.

Statistical Features

Navajo Dam will have a maximum height of 405 ft. with a total length at its crest of 3,800 ft. Its length at the canyon bottom is 1,000 ft., the natural width of the canyon in which it is located. With a maximum width at the base of 2,600 ft., the mass rises to a width of 30 ft. at its crest.

Zone 1 material required in the dam will total 9,500,000 cu. yd. of impervious soil, spread and compacted in 6-in. lifts to at least 98% of maximum density. Zone 2 will require 11,250,000 cu. yd. of gravel and sand, classed as pervious, and compacted as the fill rises. The Zone 3 portions of the dam embankment will consist of a mixture of selected clay, silt, sand, and gravel compacted by tamping rollers to 12-in. layers. About 5,400,000 cu. yd. of this material will be required. On the upstream slope of the dam will be placed 150,500 cu. yd. of riprap varying in size from 1 cu. yd. to spalls and small rock. Native sandstone of the Wasatch formation is classed as being unsuitable for riprap, and granitic Andesite, obtained from a site 65 miles northeast of the dam, will be used in place of the sandstone.

Thus, into this dam will go more than 26,300,000 cu. yd. of earth and rock. In addition, approximately 75,000 cu. yd. of concrete will be used to line tunnels and in spillway and control structures.

Project Specifications

The spillway will consist of an approach channel, concrete crest structure, spillway bridge, chute, stilling basin, outlet channel, and access house

for the drainage gallery. The spillway will be 1,600 ft. long, with a width at the crest of 138 ft. and widening to 195 ft. in the stilling basin. The channel will widen to 600 ft. immediately below the stilling basin. Elevation of the crest will be 6,108 ft. above sea level.

Total excavation on the project will approximate 30,000,000 cu. yd. of earth and rock.

The two tunnels, each 1,600 ft. in length, which are now being lined, are designed to serve the requirements of the project during both construction and final operation. The larger tunnel, 18-ft. 9-in. finished diameter, will be utilized during construction for by-passing floodwaters of the river in the spring and early summer during construction work.

The outlet works will consist of a concrete tower intake structure 280 ft. high with diversion inlet. Ultimately, the tunnel will contain a 110-in.-diameter steel pipe; a gate structure and 14-ft.-diameter concrete-lined shaft for a 6 by 13-ft. fixed wheel gate; access tunnels and shaft; tunnel access house; diversion channel and manifold anchor block; valve house for two 72-in. ring follower gates; and two 72-in. hollow-jet valves. A 30-in. pipe encased in concrete will extend from the tunnel access house to the control house for a 30-in. ring-follower gate and a 30-in. hollow-jet valve.

The auxiliary outlet works will consist of a concrete intake structure; a 7-ft.-diameter, concrete-lined tunnel; a gate chamber for two 4 by 4-ft. gates; and a 6 by 8-ft. concrete-lined horseshoe type of tunnel.

Huge Water Storage Facility

When filled, the reservoir, as yet unnamed, will reach a vertical height of 388 ft. on the slope of the dam. It will back up water in the canyon basin 34 miles, reaching into Colorado, and will store 1,712,000 acre-feet of water. The lake will have an area of more than 24 square miles.

The watershed of the basin covers approximately 3,240 square miles. Hydrographers estimate a maximum annual runoff of 2,250,000 acre-feet of water flows in the San Juan River at the dam. From 1928 to 1951 an average annual flow of 1,026,500 acre-feet was recorded. The annual minimum

PRECAUTIONS: Wherever there was a possibility of rocks falling onto roadways or work areas, strong barricades were erected on the cliffs to prevent accidents to workers or damage to equipment.

average drops to 326,000 acre-feet, with some years the flow diminishing to a trickle.

The reservoir site is confined to a geological formation commonly classified as the Wasatch and consists of alternating strata of sandstone and shale. The Mesaverde formation, a massive sandstone stratum commonly found in most of the Western States, is said to lie about 5,000 ft. below the damsite. A well drilled a few hundred feet westerly from the site ten years ago struck a daily flow of 5,000,000 cu. ft. of gas, and is reported to still be a good producer.

Erosion has developed many canyons and strange forms in the sandstone and shales existing throughout these western regions. Pinon pine, juniper, and sagebrush grow profusely over the ridges and slopes of the lower hills and valleys, while ponderosa pine, spruce, and scrub oak grow in their respective zones in the higher elevations on the slopes of the San Juan Mountains.

Project of Great Value

Without the completion of the work described statistically in the preceding paragraphs, the San Juan River Basin would continue to be a desert land existing between the extremes of excess water during snow-melting run-off periods or cloudbursts and drought in the summer and autumn. In the summer, small dams of brush and rock have been piled up in the river bed to divert meager flows of water to thirsty ranches scattered along the canyon and valley. Many gun fights and deaths have resulted from the quarrels over water rights along these Western streams. Even today the Bureau of Reclamation has become involved in a controversy over water rights and stream diversion. Near neighbors across the continental divide in the Rio Grande River Valley—in Albuquerque and other cities—have watched enviously as flood waters from the San Juan watershed emptied into the Colorado River and Lake Mead. Plans were made to divert a considerable quantity of water through a tunnel to sandy, dry lands of the Rio Grande Valley. Alarmed by these acts, which might establish legal precedence, many groups are entering into programs of protest

LINE DRILLING: The lines for the grout cap were started by using jackhammer bits and, then, as work progressed, spade bits were put to use. The geological formation in this section is a massive sandstone.

against such diversions, because it is believed they may endanger the physical and economic needs of an ever-increasing population on the western slopes of the continental divide. Other political groups in New Mexico are girding themselves as strongly for a battle which will, no doubt, be carried to the floors of the legislative halls in Washington or even to the United States Supreme Court. Opponents to the diversion claim that long-recognized riparian rights of individuals and communities existing along these rivers are being disregarded and jeopardized.

The relations of the Bureau of Reclamation with the various groups of the area through the years have been excellent. Many problems have naturally developed, which required painstaking study before solutions could be found. Some groups have ever been ready to block any undertaking proposed for general good. Such antagonism usually succumbs and is soon forgotten.

Along the San Juan River and other streams of the drainage basin little settlements up to three-quarters of a century in age have been built. Fertile ranches and pasture lands have been developed. Amicable arrangements must be made to satisfy as much as possible all those affected in land acquisition in areas to be flooded. This is one of the most serious problems and all phases must be cleared before work can be commenced. That this has been satisfactorily done is a credit to the Bureau of Reclamation.

Another serious problem is the removal of interments from the little cemeteries where loved ones are buried. Contracts are executed with reputable undertaking establishments to complete such programs with every consideration for those affected. From the area to be inundated the work thus far has included exhumation of 32 bodies from three community cemeteries and one family cemetery. Interment in one cemetery dated back to 1876. At Rosa, a small, predominantly Spanish town on the Colorado-New Mexico border, near the head of the reservoir 34 miles from the dam, two cemeteries, with total burials of 600 during the many years of its existence, remain for removal and reburial.

GATE SHAFT: The outlet gate shaft, 14 ft. in diameter, required steel rings and lagging near the surface to support the weathered sandstone.

Several miles of the Denver and Rio Grande Southern narrow-gauge railroad will be removed and relocated above reservoir level.

Search must be made for ruins, artifacts, or other remains of the prehistoric peoples who lived there 800 or a thousand or more years ago. In the frenzied search by prospectors, geologists, drillers, and roadmakers for nature's hidden treasures of uranium, oil, and gas, little attention was given to remains of civilizations that disappeared centuries ago. However, the Bureau of Reclamation works closely with all interested groups in the study and preservation of the things which contribute to our knowledge of the ancient days. In the Department of the Interior, capable men serve to make or aid all archaeological investigations in areas affected by any program of the Department of the Interior or its branches. The New Mexico State Museum of Natural History is cooperating with the Bureau of Reclamation and the Department of the Interior in the study of ruins, hieroglyphics, or petroglyphs which may be inundated as the waters rise in the new lake.

Contractor's Construction Program

Construction of Navajo Dam is being performed under the direction of the Bureau of Reclamation of the United States Department of the Interior under a contract with Morrison-Knudsen Company, Inc., Henry J. Kaiser Company, and F. & S. Contracting Company. The prime contract, in the

OUTLET TUNNEL: A completed section of the outlet tunnel looking toward the gate chamber. Driving the tunnel was rapid, with work being completed in a little over three months.

amount of $22,822,624, was awarded June 25, 1958, and provides for completion March 19, 1963.

The work program is being actively managed by the Morrison-Knudsen Company, Inc., whose head offices are in Boise, Idaho. Two 9-hour shifts daily are grinding away in high gear to cut every day possible off the 1,700 construction days allotted for completion of the contract. A daily average of more than 45,000 cu. yd. of earth and rock is being wheeled into place and compacted.

On July 31, 1959, with approximately 21% of time elapsed, the big job was estimated to be 33% completed. To accomplish this, every operation is planned well in advance. That bane of dirt movers—proper saturation of soil with the optimum moisture for placement—is accomplished by commencing the wetting down of the borrow areas from which Zone 1 material will be obtained, as long as six months in advance of its excavation. Wetting down of fill in place is reduced to a minimum, and uniform compaction is readily obtained.

The excavation of the three classes of material is kept well separated to avoid congestion of equipment in pits and on haul roads. Haul roads are wide and maintained with more care than the average city streets. If a major excavating unit breaks down, the equipment serving it is quickly shifted to other locations. If the wheels are not moving, the job is idle. Shops for the maintenance of the contractor's equipment are located downstream from the damsite but close to the job. A corps of capable mechanics works around the clock, if necessary, to keep the equipment going.

Natural stream actions during high water or flood periods in centuries past have helped to separate or classify the different materials for the dam in a way that no modern machinery could have equaled. Swirling back eddies of the river have deposited clean beds of ideally graded Zone 1 material. These beds vary from 3 to 8 ft. in depth. All organic material has been washed away. Below these beds of soil are found clean deposits of uniformly graded rock and sand. The rock and sand for the Zone 2 and Zone 3 classes are excavated from the river bed and, by the time they are placed in the fill areas of the dam, are still thoroughly and uniformly saturated for subse-

quent compaction. It has been reported by observers that nowhere else in the United States has as well graded a deposit ever been found.

Haulage and Excavating Equipment

Eleven TSS24 Euclid Carryalls, equipped with twin engines, "fore and aft," and developing a combined total of 570 hp., pull out of the Zone 1 borrow pits with 25 to 30-cu. yd. loads. Four TC12 Euclid Pushcats are used to hurry their loading and get-away to the dam.

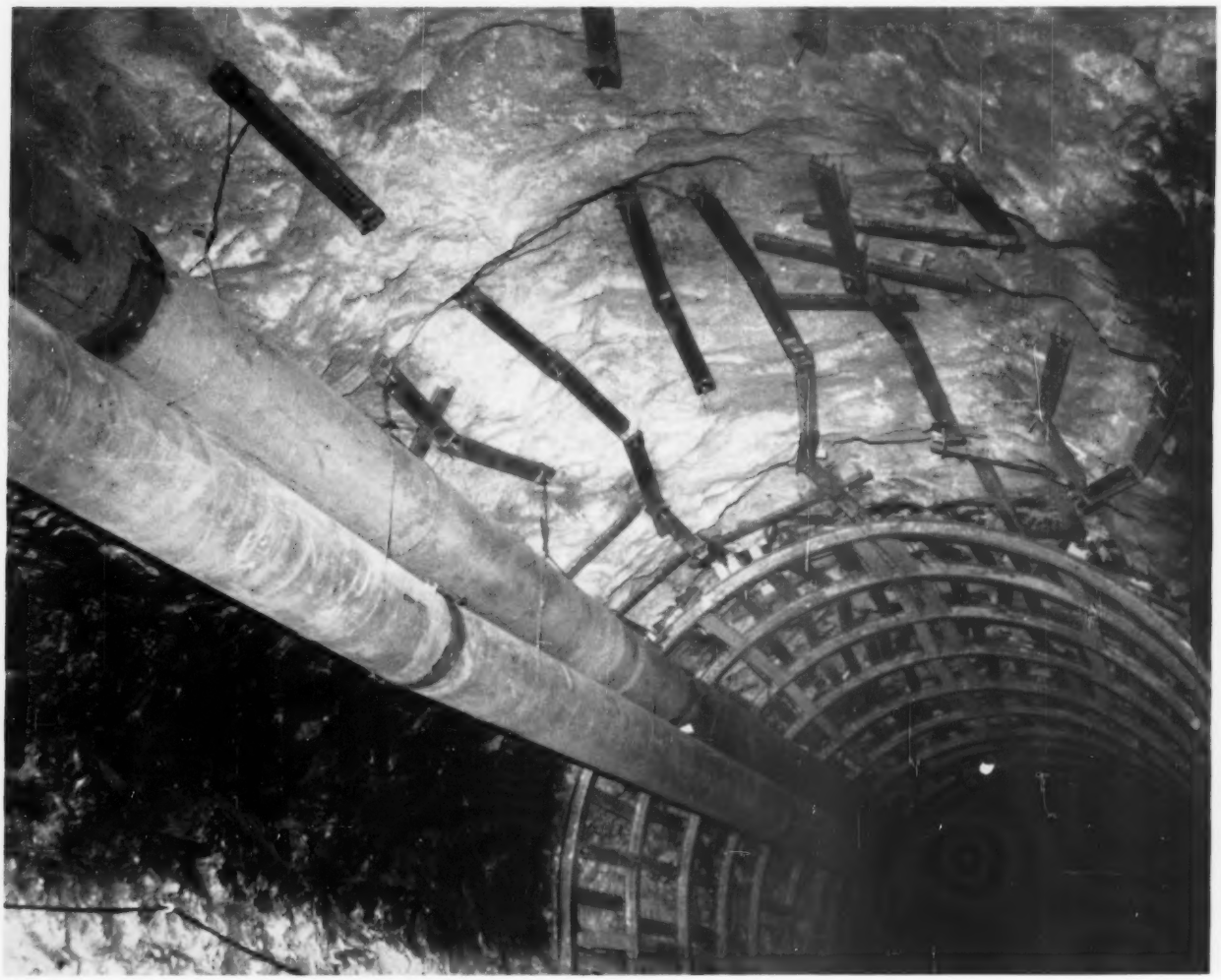
Twelve Euclid "Bellydumps," toting up to 30 cu. yd. each, work out of the Zone 2 and 3 pits. With level haul roads from the loading unit no auxiliary equipment is required as boosters.

A 450 Monighan dragline with a 125-ft. boom and a 17-cu. yd. bucket attached loads gravel from the river bed to a 65-cu. yd. loading bin. The bin is constructed with two specially designed gates to prevent clogging of the chutes and dump, and speeds loading of the big "Bellydumps" when in position under the bin for their loads. The Monighan was rated as a 9-cu. yd. unit when using the 165-ft. boom, but a 40-ft. section was removed to enable the contractor to use the larger drag bucket. Lengths of haul range from 2,500 to 6,000 ft. A large Euclid crawler-type conveyor loader is also used to supplement the Monighan in loading of material. This unit is capable of excavating and loading up to 1,200 cu. yd. per hour.

Three 900-cu. ft. Gardner-Denver portable compressors supply compressed air for drilling or other needs on the job. Five 800-cu. ft. Ingersoll-Rand stationary compressors were used for tunnel driving. With the tunnels completed, all drilling on the job is now done with Ingersoll-Rand Jackhamers using detachable bits, or with four track-mounted Gardner-Denver wagon drills.

Soil Compaction Readily Attained

Following its placing in the fill of the dam, Zone 1 soil is blended or intermixed with a tractor-drawn 18-ft. combination two-gang disk equipped with 30-in. disks and a rear-end scraper. The disks provide a uniformity of surfaces and intermix before compaction and the scraper permits leveling down of any high spots in the spread. Compaction is obtained through the use of a Ferguson self-



DIVERSION TUNNEL: With the exception of two very short sections, the roof of the diversion tunnel was of such nature that the installation of roof bolts, steel ribs, and lagging was necessary for support.

propelled tamping roller consisting of four rollers with each unit self-propelled. One operator controls the machine. The machine has a gross weight of more than 100,000 lb. The rollers are studded with typical "sheepsfeet."

An Essick vibratory roller with three rollers in echelon is utilized in the compaction of Zone 2 embankment and develops a high degree of compaction, it is reported, with a minimum of passes.

Tunnel Blasting

In driving the outlet tunnel, the contractor met variable rock conditions. This situation necessitated continual changing of the drilling and loading pattern, so no standard procedure can be described. The normal face in the outlet tunnel consisted of an 11-ft. 8¾-in.-radius arch section, and a rectangular section of 8 ft. 2 in. by 23 ft. 5¾ in.

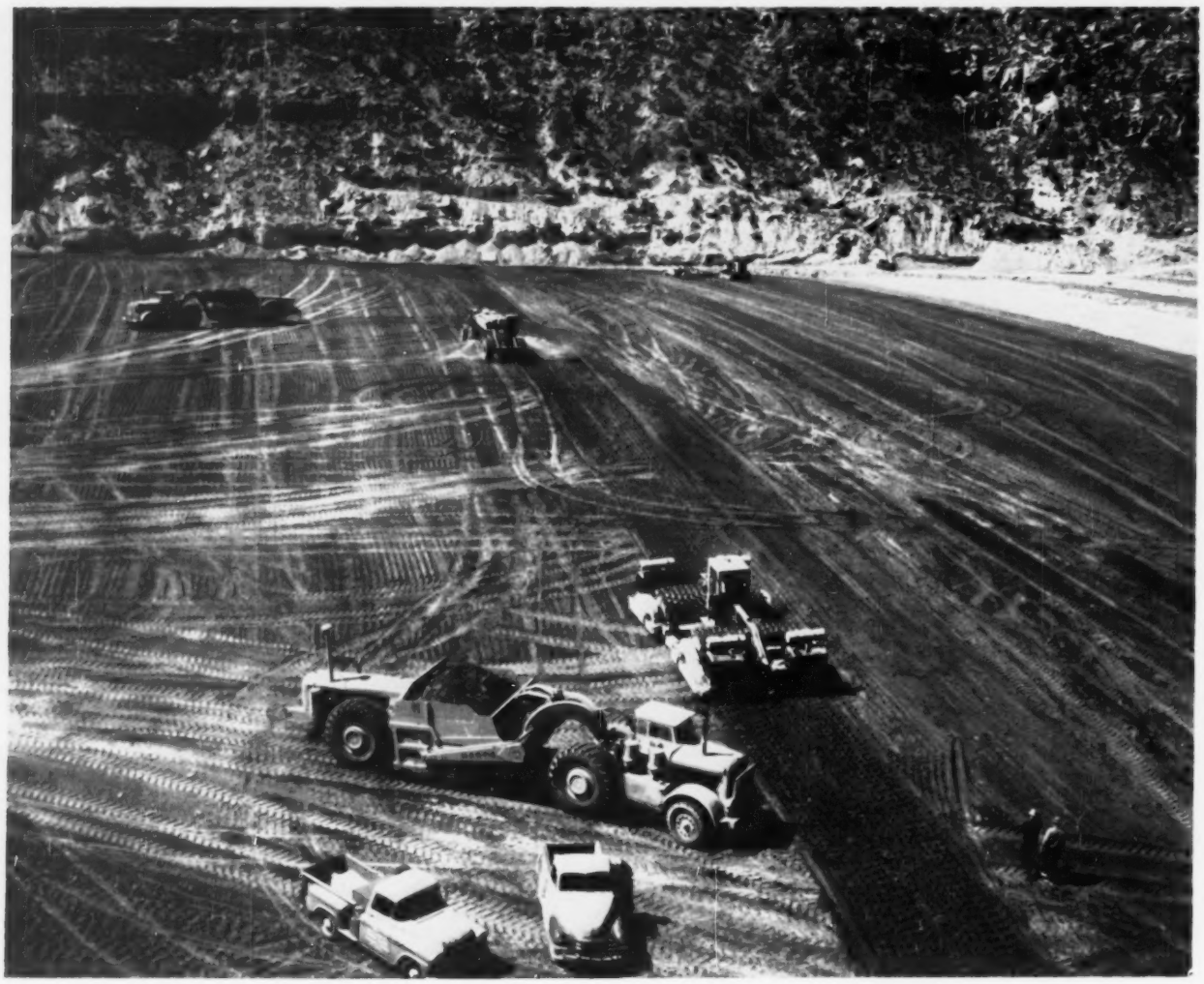
Drilling was done from a two-deck truck-frame jumbo on which were mounted nine Gardner-Denver drifter drills, Model D-93-ISA.

Each round averaged 94 holes, each of which was drilled 9 feet deep to obtain an advance of 7 ft. Approximately 200 lb. of a semigelatin type of dynamite were loaded in each drill round. This was detonated by delay caps using periods No. 1 to No. 10. The resulting powder factor was 2.25 of explosives per cu. yd. of blasted material.

Tunnels Speedily Completed

Approximately three months were required to complete the tunnel driving. Work was started October 20, 1958, and finished January 27, 1959. No more than the ordinary problems of maintenance were said to have been encountered. With the exception of two very short rock sections, the diversion tunnel was continuously supported with steel ribs.

Sinking the shaft for the installation and operation of the fixed wheel gate and control shaft was expedited by first drilling a pilot hole with a rotary drilling rig. This was followed by reaming to 36 in. and, in turn, was followed by ring drilling and blasting for the required lined diameter of 14 ft. The shaft centered directly over the larger tunnel, and rock broken in the sinking fell to the tunnel invert from



PLACING AND COMPACTING: Zone 1 area of the dam required approximately 9,500,000 cu. yd. of impervious soil, spread and compacted in 6-in. lifts. Compaction was obtained by a 100,000-lb. four-unit Ferguson self-propelled tamping roller.

where it was loaded into trucks and transported to the dump. The shaft is 360 ft. deep. Concrete lining will commence at the bottom of the shaft and will be made in a continuous pour.

Steel forms 48 ft. in length are being used in the lining of the tunnels.

Concrete on the Navajo Dam

Concrete on the Navajo Dam is being batched and placed by the Whittle Construction Company of Dallas, Texas, under a subcontract with the prime contractors.

Placing of reinforcing steel is subcontracted by O. E. Salyer, Inc., of Los Angeles.

Drilling of grout holes and grouting are subcontracted by the Cannon Diamond Drilling Company of Los Angeles.

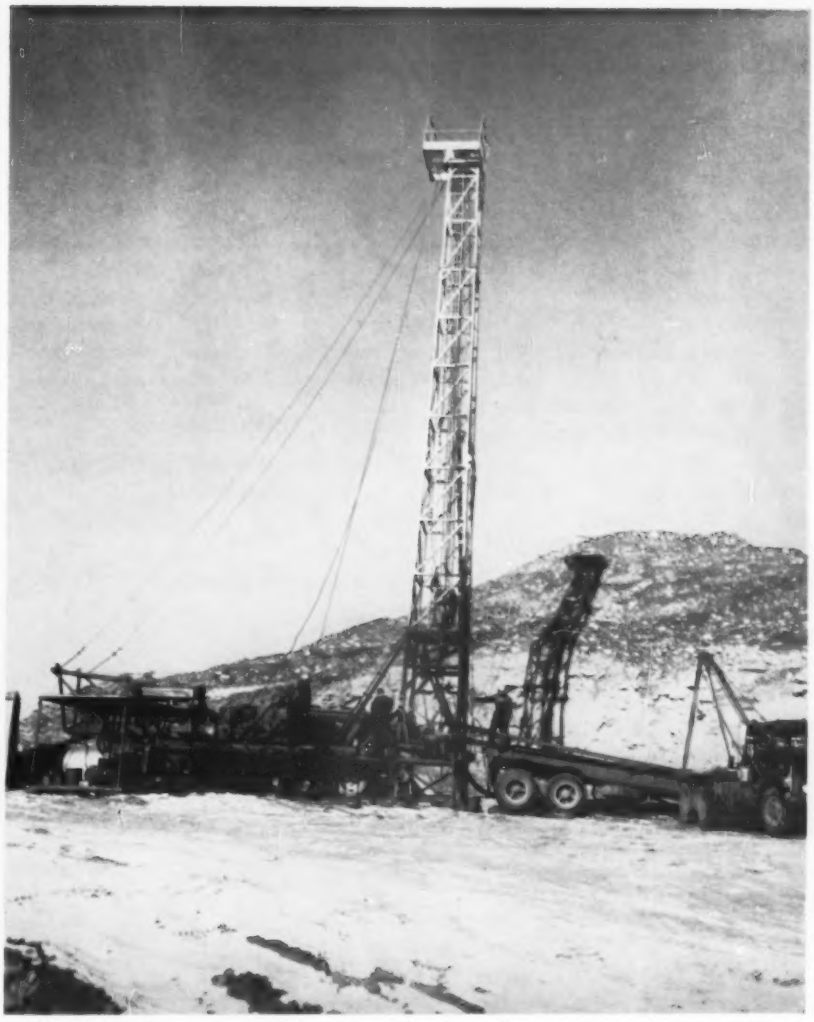
Aggregates for concrete are obtained from beds adjacent to the dam and are processed through the contractor's plant. Concrete is designed for 3,000 p.s.i. with a maximum of 3-in. aggregate being used. A pozzulan admixture, approved by the Bureau of Reclamation, is being used with the cement to provide additional workability and a lower water content. Slump is rigidly controlled by the Bureau of Reclamation inspectors. Two pumpcrete units utilizing 8-in. slick lines are maintained for most placing work.

Approximately 75,000 cu. yd. of concrete will be placed on the job.

Anchor bars 1¼ in. in diameter and embedded 8 ft. into the rock and set on 5-ft. centers will supply anchorage for the reinforcing steel and concrete which will be spread on the spillway slope. This concrete will have a minimum thickness of 18 in. and will lie on a 1½ to 1 slope. Below the spillway the stilling basin will also be constructed of reinforced concrete.

Approximately 40,000 cu. yd. of rock remain to be excavated from the spillway channel.

Grouting under the dam and the concrete cutoff wall on the axis is conforming to the usual Bureau of Reclamation pattern of curtain grouting. Low-pressure grouting is done through 2-in.-diameter holes drilled on 10-ft. centers and up to 80 ft. in depth. After the low-pressure grout cap has been completed, the high-pressure grouting will be undertaken through holes drilled as deep as 250 ft. Pressures up to 135 p.s.i. have already been applied to the substrata. Observation is constant to prevent pressure uplift or disturbance of installations or formations in geologic strata.



PILOT BORE: Sinking the shaft to the gate chamber of the outlet tunnel was expedited by first drilling a pilot hole with a rotary drilling rig. This pilot shaft was enlarged to the specified 14-ft. diameter by ring drilling and blasting.

Safety Program

Excellent cooperation exists between the Bureau of Reclamation and the contractor's forces in observance of the safety practices maintained as a part of all Reclamation projects. In addition to the supervision by the project officials, the contractor effects strict observance of the safety rules through his own safety department.

The contractor's major problem at present appears to be to control the speed at which operators wish to drive haulage equipment. Several collisions have occurred, but fortunately none have had fatal results. Discharges of employes for failure to cooperate by observing the rules regarding excessive speed would appear to be the only ready solution to the problem, and should help to reduce accidents.

One fatality has occurred on the job.

Employment, Housing, Schooling

The prime contractor on the Navajo Dam employs 400 or more men and women in the office, shops, and on the two-shift job schedule. The subcontractors use an additional 130 to 150 employes. The Bureau of Reclamation

has 35 men in the field and in its offices at Farmington there are 17 people.

A comfortable barracks with quarters for 56 men is located at the damsite and the contractor also operates an excellent mess hall for employes. Morrison-Knudsen has also established a modern trailer camp two miles downstream from the dam with complete facilities for 164 trailers. The modern trailer home, attractively equipped with every convenience for comfortable family life, is a far cry from the old-time construction camps with "rag houses" and shacks housing the families and men following the construction jobs and tunnels.

Five miles west of the damsite the Bureau of Reclamation has constructed 15 temporary houses for employes. Many of the employes of both the Bureau and contractor reside in the small towns of Aztec, Bloomfield, or Blanco, a few miles from the dam, and drive daily to and from their work. Excellent-surfaced roads reach from the many small towns of the area to the dam.

School buses convey children from the camps to unified grade and high schools in Blanco and Bloomfield during the school year. Heavy snows seldom block the roads and the schoolbus operation is seldom delayed.

Project Personnel

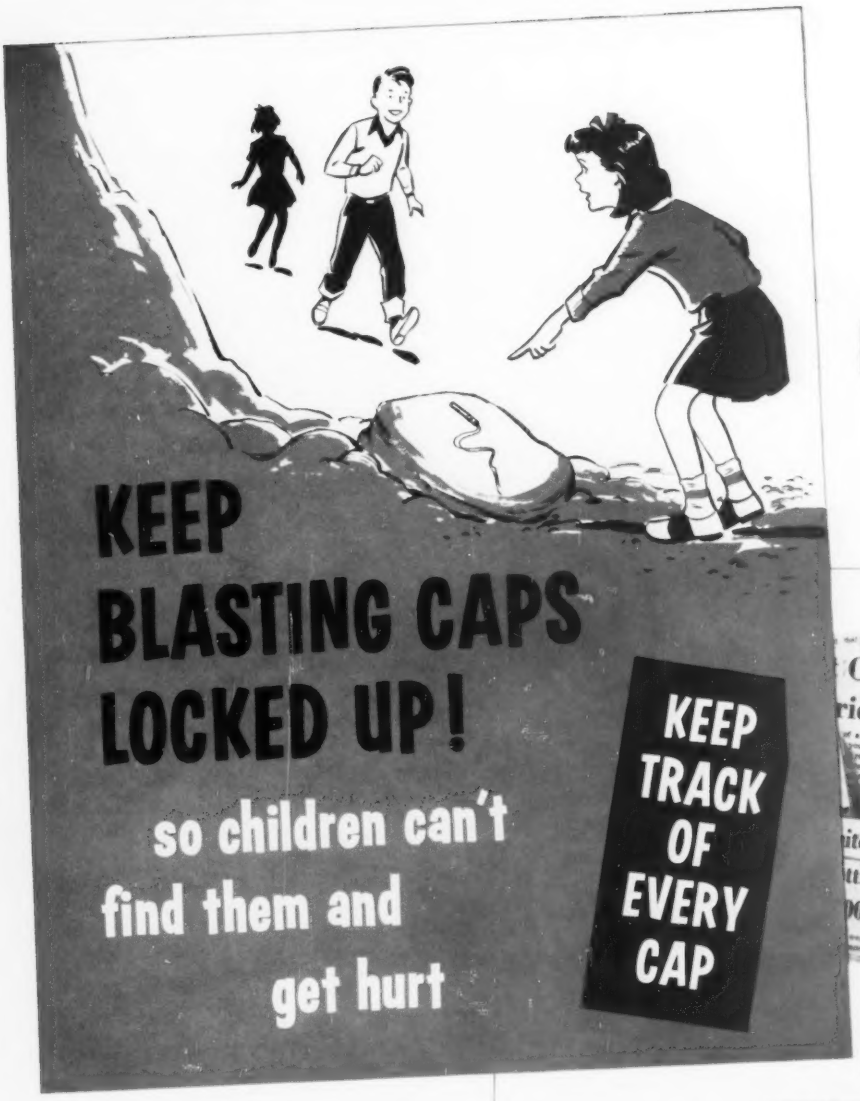
Supervisory personnel on the job for Morrison-Knudsen are H. D. "Pinky" Gard, project manager; M. L. Daley, project engineer; P. A. Campbell, office manager; and Miles Molesworth, safety engineer.

For the Bureau of Reclamation, Floyd E. Dominy, with Administration offices in Washington, D. C., is commissioner of reclamation. Grant Bloodgood, assistant commissioner and chief engineer, with offices in Denver, Colorado, is in charge of designs and contract administration.

The Navajo reservoir project is in the Bureau's Region 4 with headquarters in Salt Lake City, Utah. E. O. Larson is the regional director; W. W. Brenner is project construction engineer; E. D. Henry is field engineer; and J. D. Serry is office engineer. Fred Ward is safety engineer. Project headquarters are located in Farmington, New Mexico.

MULTIPLATE PIPES: Manufacturer's representative erecting the 144-in. multiplate pipes that were installed below the dam foundations. Sections of these pipes were trucked in and assembled at the damsite.

A Poster For Explosives Users



The Institute of Makers of Explosives has prepared for users of explosives the poster which appears on this page to remind all who handle blasting caps to keep them in a safe storage place where children cannot find them. The poster urges users to display it on the magazine door where those who have access to caps will see it.

Copies of the poster, in quantity, may be obtained by writing to The Explosives Engineer, Delaware Trust Building, Wilmington 99, Delaware.

Over Blasting Caps
ries To Boys On Trial
Polk Boy Who Lost Eye In Blast Sues For $500,000

TO THE USERS OF BLASTING CAPS

You may be familiar with the efforts of the Institute of Makers of Explosives to prevent blasting cap accidents to children. The major portion of the work of the I.M.E. in this campaign has been devoted to carrying a warning to the children of the dangers of these caps.

While the protection of the children has always been our greatest concern, the clippings shown above disclose another side of this problem.

It is obvious to all those familiar with explosives that if the blasting caps could be kept out of the hands of children, there would be no accidents to the youngsters. The Institute, for that reason, has prepared a poster on the reverse side of this sheet to caution all users of caps to take care in accounting for these detonators. **All caps taken from the magazine should be accounted for at the end of each day, and caps in storage kept under lock and key.**

We feel sure we can enlist your support in this campaign to place the poster at a point where it will be most likely to caution the users of blasting caps to remember the children.

We trust you will be able to put the poster on your magazine door or in some other conspicuous place where all those who have access to your caps will see it. Certainly the explosives industry and all explosives users will do everything possible to reduce the number of these distressing accidents.

PUBLIC RELATIONS COMMITTEE
INSTITUTE OF MAKERS OF EXPLOSIVES

Dynamite Speeds Dredging Project

Blasting, using large-size cartridges, fractures underwater layer of limestone for easy handling by dredge

WILLIAM F. HALLSTEAD°

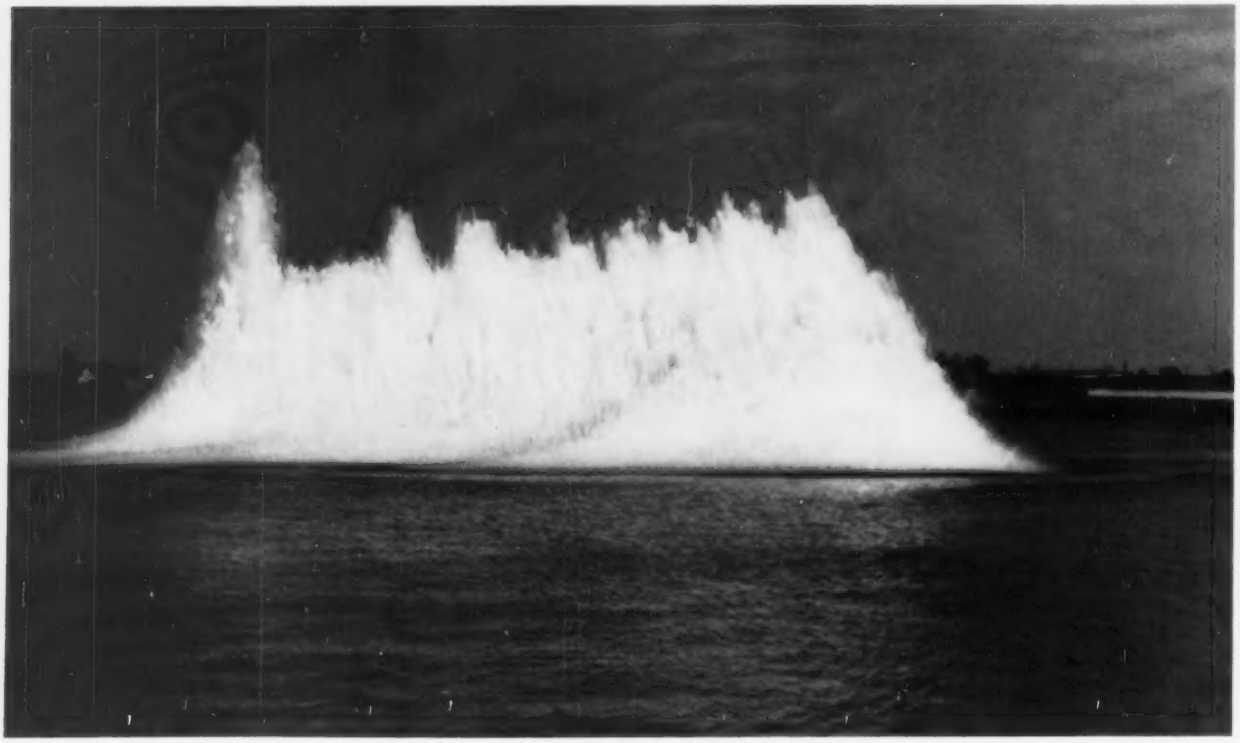
WHEN the 17-ton dipper of the dredge *Atlantic* was stymied by an impenetrable limestone layer on the bottom of the Patuxent Naval Air Station seaplane basin on Chesapeake Bay near Baltimore, Maryland, the Norfolk Dredging Company turned the problem over to Burnbrae, Inc., a custom-dynamiting firm of Baltimore. The rock layer had brought the dredge and its 32-man crew to a complete halt. If the dredging work were to continue on schedule, the rock formation on the bottom of the basin had to be fractured rapidly and adequately.

°517 Wyngate Road
Lutherville, Maryland

The Test Blast

If the rock could be satisfactorily broken without drilling, substantial savings in time and cost would be effected, Jack Loizeaux, president of Burnbrae, realized. To determine the feasibility of fracturing the obstruction simply by laying heavy charges on it beneath 11 to 13 ft. of water, Loizeaux made a 500-lb. test shot, using Hercules® 60% Gelatin Extra. The resulting 50-ft.-diameter fracture revealed the limestone formation to be some 2 ft. thick and fairly easily broken when sufficient explosive was laid upon it and only water for cover.

The job involved an area approximately 200 by 400 ft. and resolved itself into a production effort. Burnbrae, Inc., was permitted by Naval authorities to import only enough dynamite to the base for each day's blasting. This amount was brought by water aboard a tugboat from a storage site about 6 miles north on Chesapeake Bay's western shore. Upon being unloaded at Patuxent, the ex-



QUICK WORK: After an experimental blast to determine the thickness of rock formation, work progressed rapidly. The entire blasting operation required only five working days.

plosive was stockpiled for the day on a peninsula serving as a breakwater for the seaplane base. Here the 5-in. by 25-lb. cartridges of 60% Gelatin Extra were strung on 100-ft. lengths of reinforced Primacord* at intervals averaging 6¼ ft. These large cartridges, incidently, were not boxed for shipment but were transported in their sturdy 23G cylindrical containers.

Each cartridge was punched lengthwise by forcing it down upon a platform-mounted 30-in.-long punch. It was then strung on the Primacord and secured at the proper interval with scrap Primacord and bits of rope held in place by masking tape.

Two of these 100-ft. "necklaces" per shot were loaded into a small outboard-powered barge, then laid overside end to end and tied together to form a 200-ft.-long line. The barge was positioned for each loading by reference to two sets of onshore ranging markers at right angles to each other (see sketch). Each 200-ft.-long shot was laid parallel to and 10 ft. from the preceding firing.

Because of the impracticality of using lead wires, the shots were detonated by a pair of No. 6 Blasting Caps, each crimped to a 10-ft. section of safety fuse whose burning rate was 40 sec. per ft. This double fuse was taped to a 2-ft. length of Primacord.

The barge crew secured one end of each placement to a float and returned to the loading site as the blasting foreman, in a motorboat, attached the Primacord of the fuse assembly to the floating end of the Primacord and ignited the double fuse. The burning time, in excess of five minutes, provided ample opportunity for the blaster to retire to a place of safety, for even if the boat's outboard failed, the blaster could use the oars carried on the boat as an extra safety precaution.

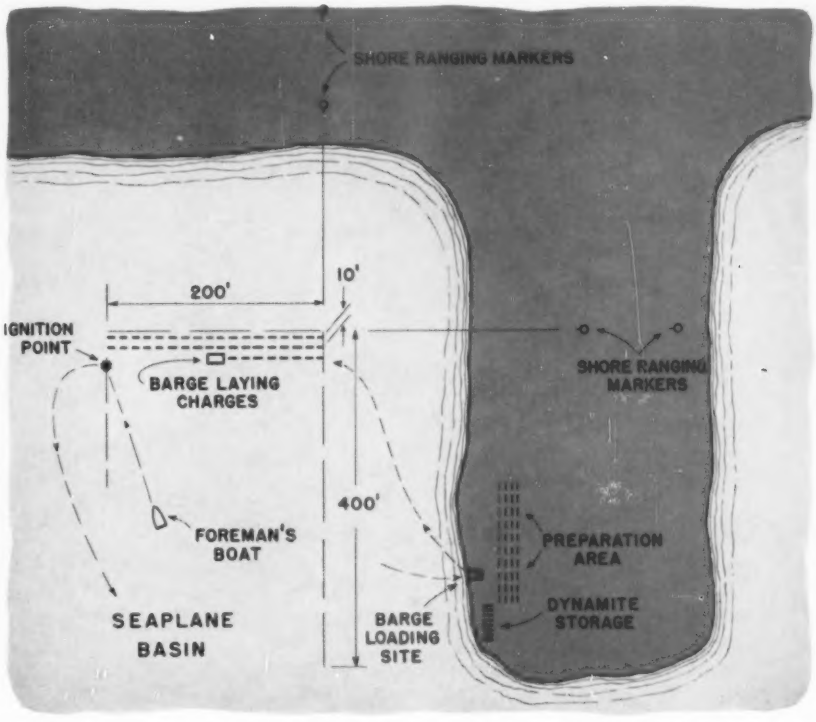
Quick, Efficient Work

The blasts, consisting of thirty 5-in. by 25-lb. cartridges (750 lb. total), detonated instantaneously. There was little ground shock and no reported damage to nearby installations. Surprisingly few fish were killed, the largest being a 9-in. rock bass.

The entire blasting operation required only five days. During the first two days, because of various minor but time-consuming complications, only 2,300 lb. of dynamite were fired. On the third day, consumption went to 5,000 lb. On the fourth, the blasting team fired 10,150 lb. of explosive, and on the last day of operation, 12,550 lb. were placed and fired. On these last two days, with five men on shore preparing charges, three men on the barge loading, and two men handling the actual firing, the Burnbrae company was able to place and fire 750 lb. every 12 minutes during working hours.

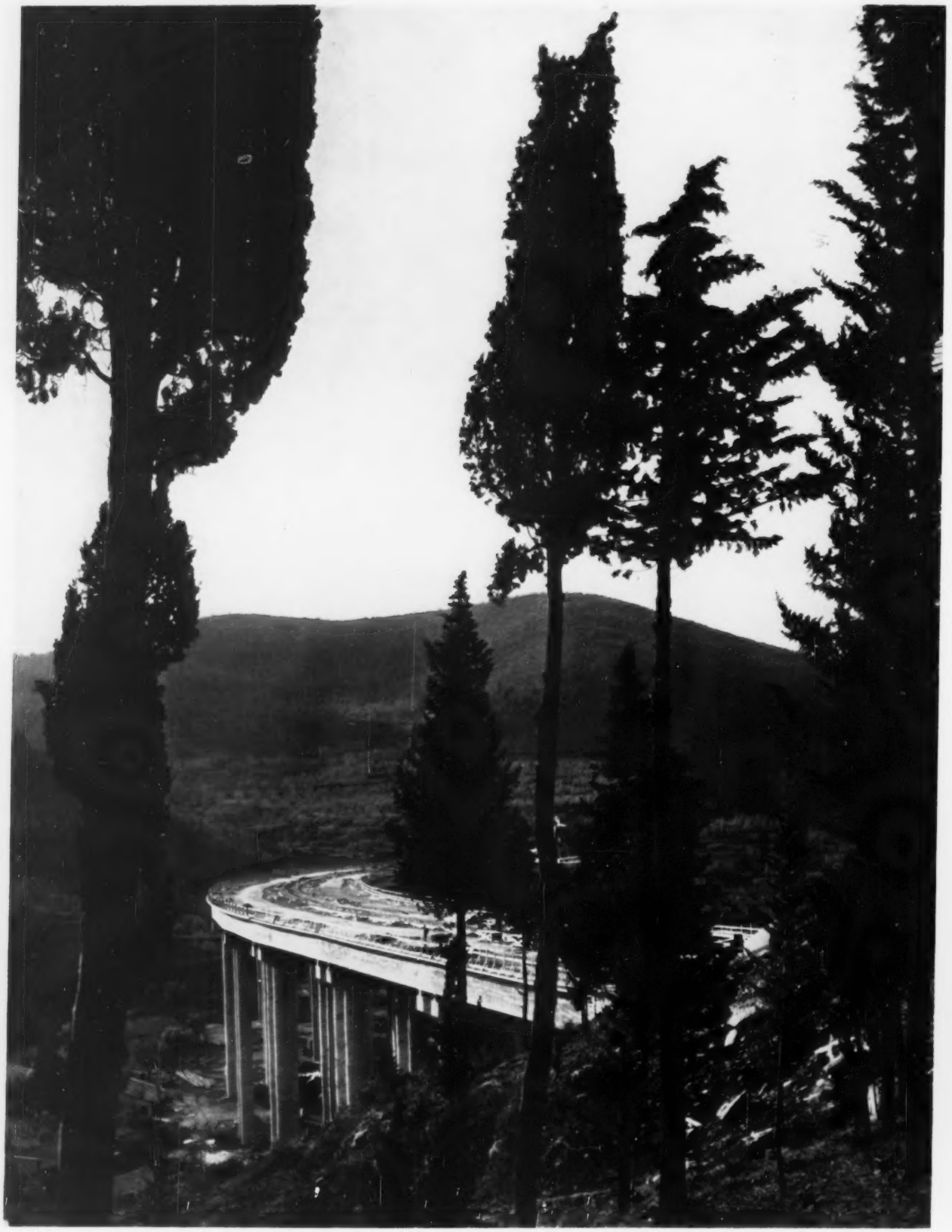
There was no rock fly whatever. Fracturing was complete, thus proving the practicability of large shots simply laid on underwater rock layers. It cannot be determined from this particular project, of course, the maximum rock-layer thickness that can be satisfactorily fractured in this manner. But the successful completion of the project did prove it to be another instance where expertly and imaginatively handled explosives accomplished what conventional methods could not.

DYNAMITE "NECKLACES": The 5-in. by 25-lb. cartridges of Hercules 60% Extra Gelatin were punched lengthwise and then strung on Primacord. Each blast consisted of two 100-ft. necklaces tied together to make a 200-ft.-long line.



WORKING PLAN: A well-thought-out plan of all phases of the preparation and blasting details contributed to the efficiency of the operation.

*Reg. U. S. Pat. Off. by The Ensign-Bickford Company



CONCRETE PIERS: Tall stilts of prestressed concrete match the Italian cedars in this delightful stretch of the Autostrada.

Highway of the Sun– First Italian Superhighway

Modeled on American turnpikes, Autostrada del Sole is inspected by members of American Bridge, Tunnel & Turnpike Association

FARRELL CASTELLANI°

THE American Bridge, Tunnel & Turnpike Association, at its annual convention in Richmond, Virginia, in October, 1958, seemed to be an alive, vibrant, and eager group, particularly for about 60 of those in attendance who were starting a trip to Europe at the close of the meeting.

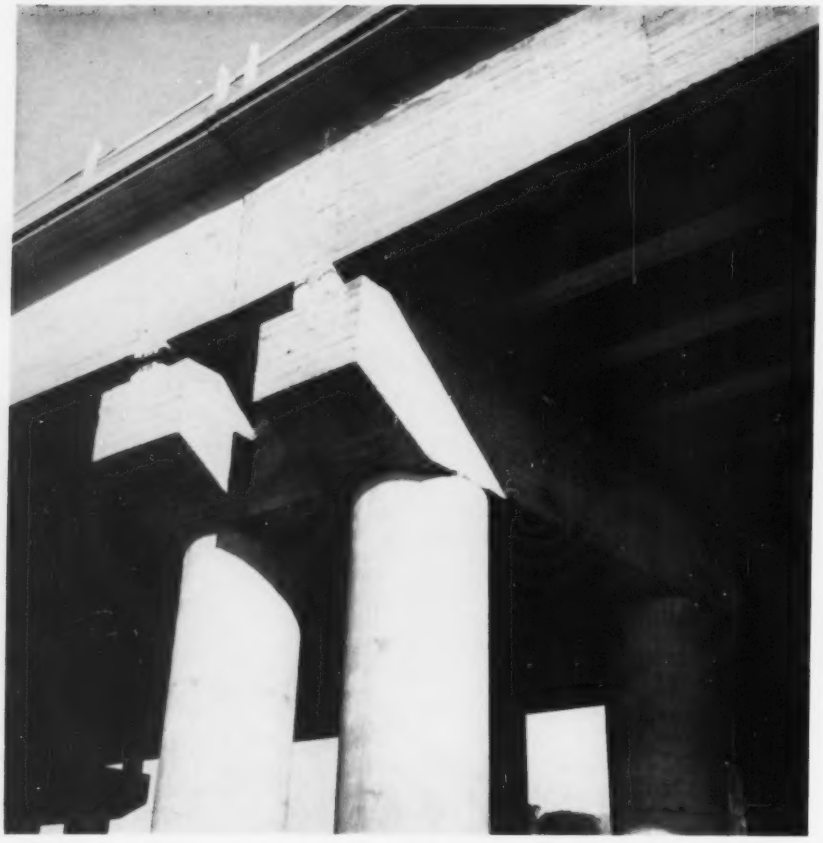
The meeting was a three-day affair topped off with a talk by Governor Almond of Virginia. It was the writer's pleasant privilege to be included in the trip, which was made at the invitation of the Italian "Autostrada," or turnpike, group, which had spent time in America studying plans, specifications, and methods of operation of turnpikes here. Represented in the American delegation on the trip were members of turnpike groups from New York, New Jersey, Pennsylvania, Illinois, Michigan, Maryland, and Kansas. The group took off on a chartered Pan American plane at Richmond, Virginia. Stops were made at Gander, Newfoundland, and Shannon Airport in Ireland, before arriving at its destination at Campiano Airport in Rome.

°Hercules Powder Company
Joplin, Missouri

450-Mile Highway

The Italians proved to be gracious hosts, giving the American visitors a fabulous reception and banquet in Rome at the Hotel Excelsior, and a dinner at Caserta at the south end of the Italian Autostrada, and one at Parma. A portion of the Italian group then accompanied us to Milan, the northern terminus of the Italian "Road of the Sun." The total mileage of

VIADUCT CONSTRUCTION: A section of the Autostrada del Sole involving the construction of a viaduct near Florence. The highway has been run on overpasses across all intersecting roads. In the Milan-Florence section, 231 overbridges and underpasses are planned.



MARINELLA VIADUCT: A detail of the Marinella viaduct near Florence. Partly because of the lack of steel, prestressed concrete was used in bridges and viaducts.

the new road, when completed from Naples to Milan, will be over 450 miles and the total cost is estimated to be over $400 million, which is being financed 51% by the Italian Government and 49% by private investors. It was surprising to learn that of all the parcels of land purchased for this big undertaking, not one legal action has been instituted for undervaluation of right-of-way.

The American group while in Italy traveled in two very modern buses and each bus had an Italian hostess. The travel route took us from Rome to Caserta, to Pompeii, and to Naples. We found a short toll road from Pompeii to Naples. The group took a side trip to Capri, back to Rome. Before the trip started, an audience with Pope Pius XII had been scheduled but he died just a short time before our arrival. We then drove to Assisi, Perugia, Florence, Bologna, Parma, Milan, a side trip to Lake Stressa in northern Italy, Genoa, San Remo, and Monaco. We boarded a train from Nice to Paris, and here the group spent four days.

Auto Traffic in Sharp Rise

Hundreds of modern apartment buildings are going up in the cities that we visited. A 32-story building is being completed in Milan, and twice as many automobiles are running today compared to four years ago. Along with this, one sees in the south oxen pulling wooden plows, highway pedestrians carrying baskets on their heads, donkey carts, bicycles, motorcycles, and scooters, the small native cars, and a few American-made cars. Italian trucks are large and most of their transports operate in tandem, and considerable freight goes over the highways in large trucks. One sees very old street cars, very modern buses; in the cities very narrow cobblestone streets in some sections; and in the open country very modern highways. The amazing thing about drivers of automobiles is that in the course of a day's driving one sees many near-misses. The roads are not made for any one type of vehicle and with all the previously mentioned conveyances on the roads you can imagine the situations which arise. Also, and this is very puzzling, knowing the Latin temperament and volubility, and the amount of traffic and near-misses, it is amazing how calm all people are in what often seemed to us a dangerously close traffic situation. The drivers seemed to handle their vehicles much as a youngster would react to his first toy.

The absence of chuck holes and road failures on existing roads was an everyday topic of conversation among the members of the touring group. The relative absence of freezing and thawing cycles evidently had a great bearing on the stability of the roads.

Right-of-way 97 Feet

The width of the completed roadway will be 24 meters, with two roadways each 7.5 meters wide. These will be bordered on the outside by a 3-meter-wide paved shoulder and divided by a 3-meter-wide medial strip on which will be planted grass, flowers, and shrubs. The shoulder strip will be for slow traffic and disabled vehicles. Total right-of-way width is 97 ft., which leaves very little distance from fence side of the road shoulder to the fence. The need of land to raise crops, especially in the fertile plains region, makes it imperative that none of the valuable land is wasted.

American turnpike roads are similarly constructed, and a comparison of the Kansas Turnpike and the Italian Autostrada will show their similarities and differences.

The Kansas Turnpike is built of concrete pavement on the eastern section and asphalt hot mix on the big end of the western section.

Each pavement is 24 ft. wide with a 10-ft. asphalt-paved shoulder. The inside shoulder is 4-ft. asphalt paved. The medial strip is 12 ft. wide and the distance from the end of the outside shoulder to the fence line is 95 ft. In Kansas the medial strip is concave, and on the Italian road the strip will be convex or built up.

Hot-mix laying machines are used in laying the asphalt but a notable difference in operations is the side

WIDE SHOULDERS: The Italian highway has a much narrower right-of-way than most American turnpikes, but the shoulders are wider to accommodate slow-moving vehicles.

SECTION OF NAPLES-CAPUA ROAD: A grating in the medial strip. Shrubs, flowers, and grass will be planted in the strip, which is 3 meters wide and slightly convex.

dump of the mix into the machine.

On our tour, we found bridges under construction and road construction well under way between Caserta and Naples and Bologna and Milan. Most of the work was going on in the plains area of Italy in the already mentioned regions, and it was indeed a surprise to see such long stretches of flat country. Bridges are being built of prestressed concrete and overpasses are now being built of arch design and only end-supported after a start with overpasses built with middle supports. Prestressed concrete requires less steel reinforcing to give required strength and the lack of steel in Italy is a serious problem. The highway crosses the Appenine Mountains between Parma and Florence and road construction in this rugged terrain will require heavy excavating and tunneling.

6 Miles of Tunnel in Appenines

Approximately 6 miles of tunnel will be built in the Parma-Florence region. Construction in the mountainous area was just getting started and very little work had been done from Florence to Rome and Caserta. The completion date of this road will be around the middle of 1960. An enormous amount of manual labor was used; for every operator of a machine there are five manual laborers. Because of the low labor rate prevailing, however, the end cost of any given stretch of road on the Autostrada is close to that of a similar stretch of road here.

The base materials there were blasted from nearby quarries, hauled in modern heavy trucks, dumped, and then hand placed. After this was done, fine material carried in baskets was poured over the hand-placed stones to fill the voids. In the south the stone for sub-base was 15 to 30 lb., hand placed to a thickness of 10 in. Then fine aggregate was hand placed to fill voids, then another 5 in. of crushed stone was laid on and compacted. This was topped with a 4 to 5-in. hot mix. In the north the sub-base was 3-in. minus material; in the Parma-Milan region it consisted of river material and was laid 10 in. thick. Then a material 2 in. minus was laid 8 in. thick and rolled, then topped with 5-in. hot mix. In the south, steam-operated rollers were used for compaction. In the north, gasoline- and diesel-motorized equipment was much more prevalent and all equipment in use was much more modern.

Many Contractors Participate

The jobs being let in slightly over

CAPUA-CASERTA SECTION: Stretching from Milan to Naples, almost the length of the Italian boot, the new superhighway shortens the previous road distance between those two cities by 70 miles.

½-mile sections for each contract meant that many more contractors perform the work than in a comparable length of road in America. Engineering checking stations are established along the route, much as in this country, to check materials and supplies, and to make sure construction practices comply with specifications. As might be expected, on many small sections of the Autostrada, it has been necessary for the sponsors to remove contractors for various reasons. In the north, we noted methods and equipment much advanced. There, a substantial quantity of aggregate was being obtained from river beds by modern equipment, and numerous hot-mix plants of about 80-ton-per-hour capacity were in operation. Shovels, drag lines, dozers, scoops, hauling equipment, hot-mix spreaders, hot-mix plants, and other heavy equipment were in evidence, with the size and capacity of most of this equipment smaller than the American counterpart. Some American equipment was in use.

Crushed-stone plants are of small capacity and when added production is needed, another plant is set up alongside an existing plant. Drilling and blasting methods are comparable to those in use in America twenty-five years ago, with jackhammers much in evidence. Bulk explosives are in general use, with little choice of grades. Plastic-insulated electric blasting caps are used, but no short-period delay electric caps that were developed in the last few years were in evidence.

Italy as a whole is very poor in natural resources such as coal, iron, oil, and metals, which make for industrial strength, but does have electrical energy derived from water power. Crushing plants generally were operated by electricity.

The writer had the experience of taking a modern train from Rome to Gualdo Tadino to the north about 125 miles. The trip was made in two hours and 40 minutes in a diesel electric train comparing favorably with our trains. No dining service, however, was available on the train. I had a long conversation with two men on this train, one of whom had been a prisoner of war in Texas, and the other an Italian contractor. A surprising number of people can speak broken English in this country. They admire and are eager to take up American methods and many of them have relatives somewhere in America.

LIGHTED HIGHWAY: This section near Naples was one of the first completed. The entire Autostrada is expected to be finished by June 30, 1960.

Great changes have occurred in this country since the war. Although war scars on cities and towns are still much in evidence, a noticeable awakening can be attributed largely to American influence and help. The mixture of the old and the new is in evidence everywhere one goes.

Service Areas Planned

Service areas with gasoline stations and restaurants will be built on each side of the Autostrada, and each service area will be accessible only to travelers on the side of the road they are traveling on. Toll stations, communications, and patrolling will be very similar to what we see on toll roads in this country.

When completed, the "Road of the Sun," one of the most ambitious single-road programs ever attempted anywhere, will traverse some of the most beautiful scenery and historical regions on earth. The route will shorten the distance from Naples to Milan by 70 miles. It is estimated that vehicle registration will again double in another five years, and the sponsors of this giant undertaking are facing a tremendous challenge in their effort to provide modern highways for this anticipated increase in vehicular traffic.

Explosives Rescue A Town

Floodwaters threatened life and destroyed property in Meadville, Pennsylvania, until the skillful use of explosives dispersed ice floes to relieve the pent-up water

ROBERT DYMENT°

DURING the 1958-59 winter season, floods in western Pennsylvania caused damages totaling an estimated $32 million. Engineers reported existing flood-control measures prevented an additional $79 million damage. It was further estimated that the damage at Sharon, Pennsylvania, was $4,900,000 and $900,000 for New Castle. Both communities are located on the Shenango River. Army Engineers stated that a proposed Shenango reservoir would have prevented most of the damage encountered in the area.

Damage at Meadville, Pennsylvania, which was flooded by French Creek, was estimated at more than $3,000,000. There are no flood-control projects in that area. The New Kensington area was reported to have suffered $2,070,000 damages from the Allegheny River. The Engineers placed the damage in Pittsburgh and immediate vicinity at $2,860,000.

The manner in which the Meadville area fought the flood waters and ice jams with explosives is a story of cour-

°220 Central Avenue
Dunkirk, New York

FLOODWATERS: Many sections of Meadville were threatened by the dammed-up floodwaters of French Creek until Army Engineers removed the ice floes by skillful blasting.

age and cooperation—cooperation between City, State, and Federal units.

The Floods Came

It was Wednesday, January 21, 1959, that the waters came to Meadville. They came suddenly and caught the town unawares. The waters rose to a record level and when they receded the damages reached millions of dollars. Thousands were homeless and uncounted others had been adversely affected.

Unfortunately, there was to be no quick recovery for Meadville, for there was a thaw, then a cold snap, and the water overflowing the banks of French Creek began to freeze. Layer upon layer of ice collected on the creek, which runs through the town, to a thickness of 6 to 8 ft. Completely blocked by a 2-mile ice jam near Cochranton, 10 miles south of Meadville, and another 2½-mile jam extending from the southern city limits, the waters of French Creek began to rise again, bringing new flood threats to the already water-logged city.

Stubbornly, the water held at about 1 ft. below flood level. Meadville residents held their breath for fear that a thaw or a heavy rain would again send the water rushing through the town to cause more chaos and destruction.

The situation was unparalleled in the history of Meadville. Civilian contractors first tried to break the jams with small charges of dynamite and succeeded in clearing a portion of French Creek, but were unable to cope with the job because of its magnitude. Responsible city officials began to realize that only extraordinary measures could relieve the threat of disastrous floods.

Hundreds of persons who had moved back into their flood-damaged homes in Meadville's fifth ward were preparing to vacate again if the emergency sirens should signal a second flood. Many other families were still being sheltered in the Junior High School building. The Red Cross was in action in this Pennsylvania city of 25,000.

After a hurried conference between City, State, and Federal officials, a six-man demolition team headed by Lt. Raymond May, Jr., from "B" Company, 19th Engineer Battalion, Fort George G. Meade, Maryland, was flown into the stricken city by helicopter. An emergency meeting was called at the Pennsylvania Highway Department office to take steps for necessary highway closings, stemming from the demolition work.

HELP BY AIR: An Army Engineer demolition team was flown to the stricken area by Army helicopter. The helicopter was also used to place some of the explosive charges on the large ice floes and masses of floating ice and debris.

Experimental Blasting

After experimental efforts, the Army men discovered a way to break the ice, but their progress was agonizingly slow in relation to the total amount to be cleared. The ax hung over Meadville as new floods threatened. On January 30, twenty-five more men from "C" Company of the 19th Engineer Battalion arrived at Meadville and were reinforced by twenty-five more the following day. Work on "Operation Ice Crusher" began in earnest, under the command of the XXI U. S. Army Corps.

Army teams engaged in the operation were learning the hard way. While trained in the science and employment of explosives, Army Engineers do not receive specific schooling in demolition of ice barriers.

TNT in 1-lb. blocks was the explosive selected for use. A series of 16-lb. charges was used in most of the clearing. Some small 8-lb. and some larger charges, approximately 32 lb., were also used. A rough estimate shows that 1 lb. of TNT per 15 cu. yd. of ice was used.

In heavy ice, the river water acted as a tamping agent for the explosives used. On thin ice, in the vicinity of 8 in. thick, a pressure charge was used on top of the ice, with no tamping. Primacord* detonating fuse was used to tie the blocks of TNT together. It was strung to the shore where one regular blasting cap and fuse was used to detonate all charges in the series.

Working ten hours a day in the bitter cold, the Engineers crossed and recrossed the treacherous ice, carrying bundles of the explosive. At the same time, floating ice blasted away from the jams had to be disposed of as it drifted downstream. In freezing temperatures it had a tendency to collect and form new obstructions.

H-23D helicopters were used to place 16-lb. charges of TNT on large ice floes and masses of floating ice and debris as they started downstream. Doing much of this work was the team of Chief Warrant Officer Lee Bartholomew, who piloted the "chopper," and Lt. Adrian D. Atkins, who placed and detonated these charges. Thanks to their often heroic efforts, blasting by demolition crews working on the main jams could continue.

*Reg. U. S. Pat. Off. by The Ensign-Bickford Company

The main packs were blasted away by cutting 18 by 18-in. holes in the ice with one-man, gasoline-operated chain saws. Three to 15 charges of varying sizes were planted across the ice in one of four patterns, depending upon the formation of the jam. The TNT was detonated by Primacord, which was wrapped around the charges and strung across the ice to the firing point. A regular blasting cap and safety fuse was then attached.

Blasting Patterns

One blasting pattern selected was to place three 8-lb. charges of TNT equally spaced across French Creek and 80 ft. from the open edge of the ice. This method was used when the thickness of the ice was uniform throughout the area to be removed.

For the second blasting pattern, two 8-lb. charges were placed 80 ft. from the open end of the creek. A single 8-lb. charge was placed 150 ft. from the shelf edge, forming a V-shaped pattern with the other two. The two charges were fired simultaneously to shatter the ice formation, followed, after a 30-sec. delay, by the single charge to create a pushing force to move the ice downstream.

Another method was to equally space three 8-lb. charges 80 ft. from the shelf edge and a second line of charges 150 ft. from the shelf edge. The second line of charges was fired 30 sec. after the first, giving the needed push to break off a large chunk of ice.

Also proved successful was a diamond-shaped blasting pattern involving a single 8-lb. charge placed 80 ft. from the shelf edge and in the center of the ice. One hundred and fifty feet from the shelf edge, two charges were spaced equally across the creek and another single charge was inserted 200 ft. from the open end of the ice. The leading single charge and the two center charges were fired simultaneously to fracture the ice. The remaining single charge was fired after a 30-sec. delay to move the broken ice downstream.

By February 7, eleven days after the work had begun, a channel was blasted through the last of the heavy ice on French Creek. As suddenly as it had risen to flood stage, the creek began to recede, dropping more than 3 ft. in 24 hours. Cleanup operations continued the next day and at 3:30 p.m. that afternoon, the last bundle of TNT was detonated. Approximately 3,000 ft. of ice had been blasted downstream daily since the first Army demolition team of six men reported to the stricken area on January 28. A total of 56 men working 4,030 man-hours had used 12 tons of explosive to clear 4.7 miles of ice.

The 19th Engineer Battalion men said the big factor in "Operation Ice Crusher" was speed. The ice could have been blasted more economically if it had not been necessary to clear it as soon as possible to remove the flood hazard. On the other hand, it was necessary to bite off small chunks of ice so that the current would carry them downstream.

Job Well Done

As Second Army's 19th Engineers prepared to go home, Meadville city officials expressed their gratitude. A letter from Mayor George X. Simonetta reads as follows: "During a period of extreme winter weather and under most hazardous conditions your men continued to do a most effective and efficient job in removing the ice jams south of our city. The city of Meadville is deeply indebted to the men of Second Army and the XXI U.S. Army Corps for the outstanding work they have done."

Meanwhile, the City of Meadville had a tremendous cleanup operation on its hands from the flood damage.

Kebert Construction Company, which had the cleanup contract for the south end of town, used a TD 14 International bulldozer to first open all streets for emergency traffic as rapidly as the water receded. After the flood waters had left the streets, the job of ice removal began. This was done with a TD 14 bulldozer, a Galion No. 160 grader, a Michigan 175-A highlift with a 3-yd. bucket, and three Mack 16-yd. tandem trucks.

Keystone Construction Company utilized the same procedure in its fifth-ward contract with the following equipment: one Caterpillar No. 12 grader, one Caterpillar No. 955 highlift, one Michigan No. 175 highlift, a Hough Payloader, six International 4-yd. trucks. After the Street Department garage had been cleaned and the department's flood-damaged equipment placed in running condition, the department's force and equipment entered the cleanup program. Their primary work involved opening sidewalks with a Hough Payloader. The cleanup and removal work lasted about a week. In that period, 1,000 truckloads of ice were hauled from flooded areas. The city cleanup work was done under the general supervision of Minor Layton, Street Department foreman.

EXTENSIVE DAMAGE: Floodwaters did much damage in the area, as evidenced by this photo showing how the water undermined one of the highways leading to Meadville.

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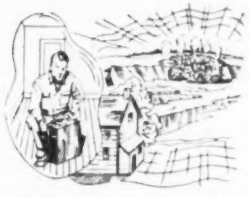

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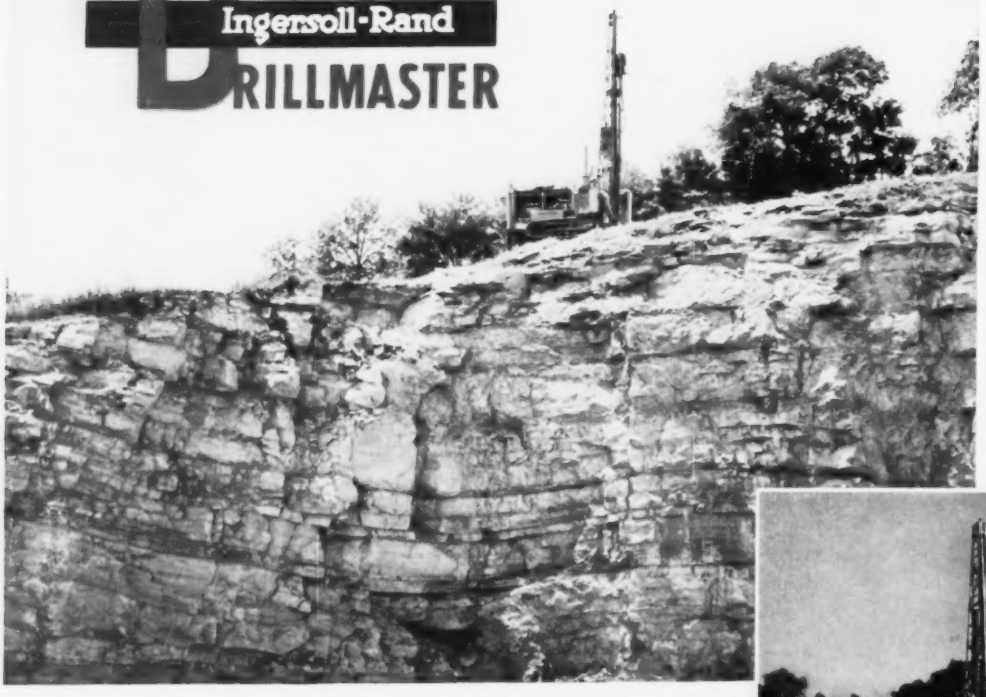

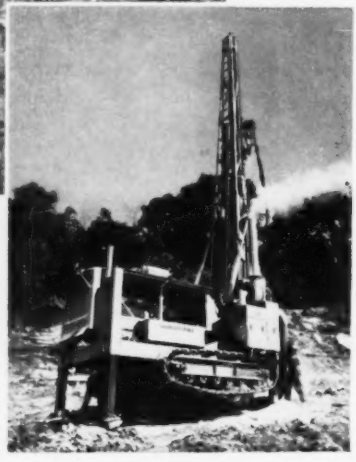

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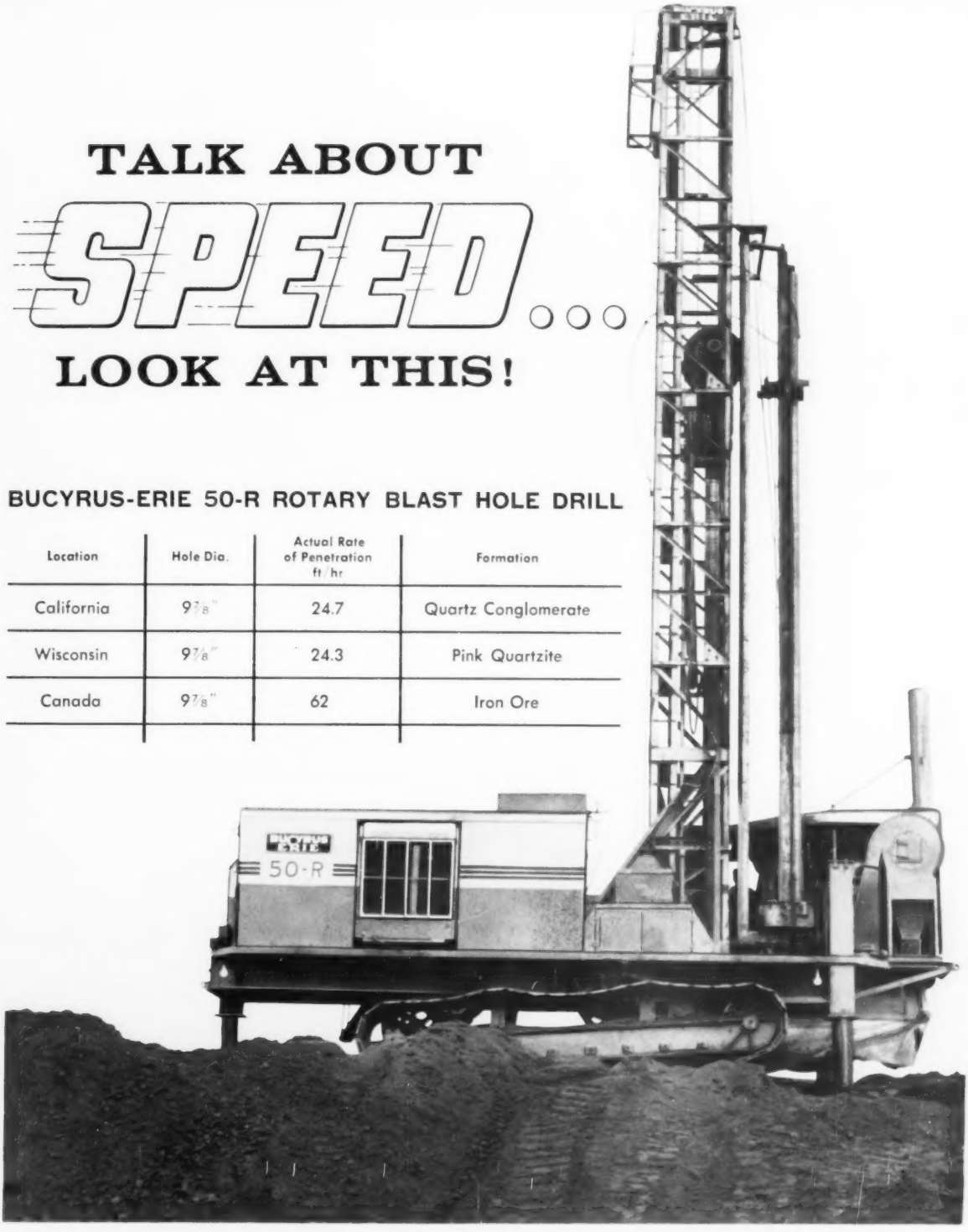

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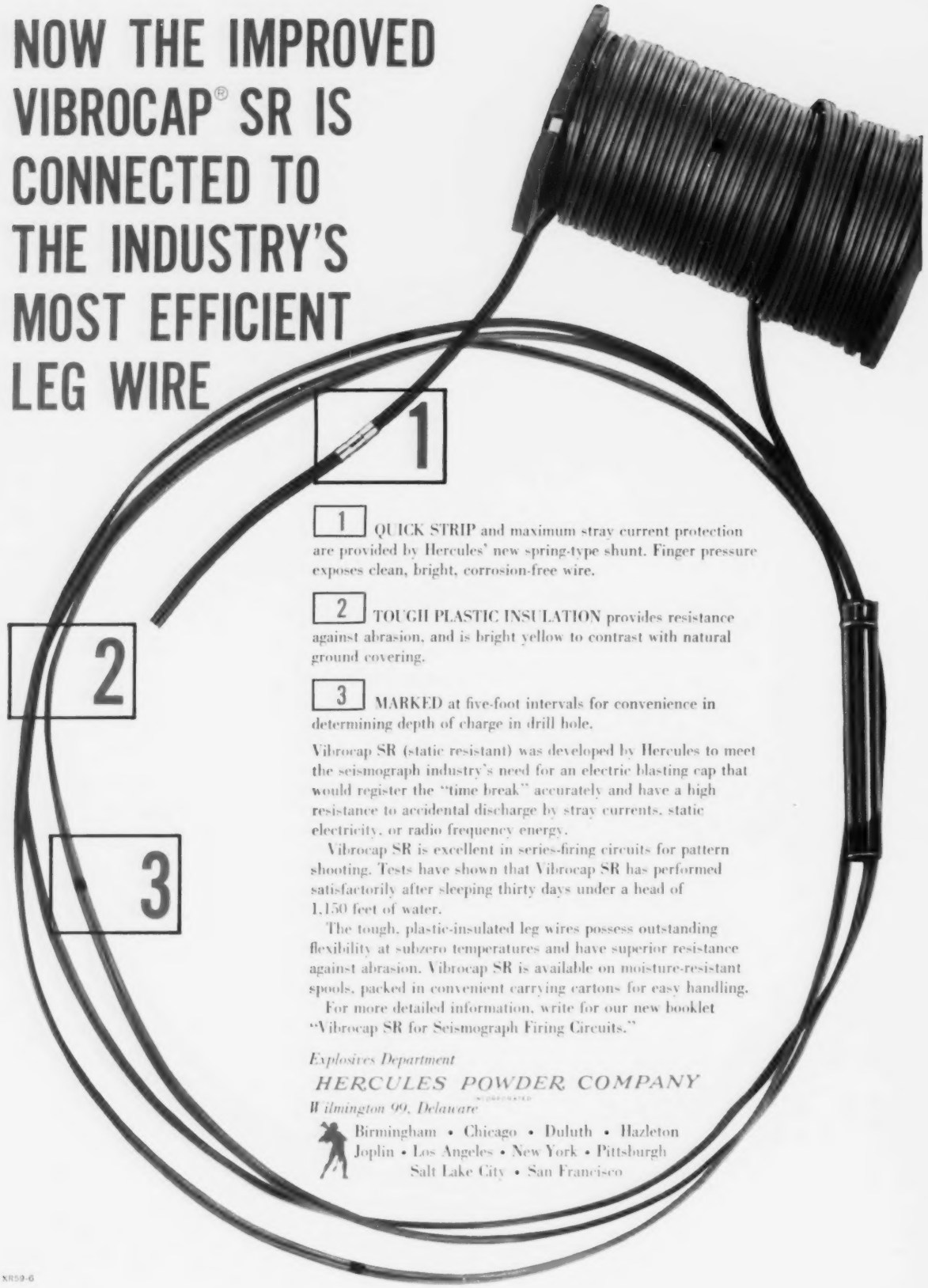

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